Gravity… Can we stop the flow of water?

Standards Statements:
3.2.10.A – Apply knowledge and understanding about the nature of scientific and technological knowledge.
3.4.10.C – Distinguish among the principles of force and motion.
National Standard:
- Knows that all energy is considered to be either kinetic energy, potential energy, or energy contained by a field.
- Understands general concepts related to gravitational force.
Content Objectives:
Students will be able to:
1. Explain how gravity affects processes on Earth.
2. Compare and contrast Earth's gravity with microgravity.
3. Explain how a freefall experience simulates a microgravity environment.
Process Objectives:
Students will be able to:
1. Neatly record and organize observations.
2. Communicate with others concerning a microgravity environment.
Assessment Strategies:
1. Neatly organizing and recording of observations collected during can toss.
2. Creation of a graphic organizer to compare and contrast microgravity to gravity.
Procedures:
1. Introduce Microgravity and allow students to read *Microgravity*.
2. Discuss their understanding of microgravity in comparison to the gravity of Earth.
3. Introduce the challenge: Can we stop the flow of water from this aluminum can?
4. Allow students to brainstorm ways that this might be accomplished.

Suggested Level:
Intermediate/Secondary

Standard Categories:
3.2 – Inquiry and Design
3.4 – Physical Science, Chemistry, and Physics

Materials:
Empty Aluminum Cans
Thumb Tack
Catch Basin
Water
Paper Towels

Instructional Strategies:
Cooperative Learning
Inquiry
Discussion

Related Concepts:
Organization
Communication Skills
Objective Observation
Estimation

How can we stop the flow of water?

An inquiry activity will be used to investigate the behavior of materials in a microgravity environment.

Thought questions to begin:
Will water continue to flow from aluminum can when subject to a simulated microgravity environment?
How can we simulate microgravity while on Earth?

Investigation:
To investigate the impact of microgravity on water flowing from a can, follow the following instructions carefully:
1. Obtain an empty aluminum can and a thumb tack.
2. Puncture a small hole on the side of the aluminum can approximately 1 cm from the base.
3. Obtain a catch basin.
4. Cover the hole in the side of the can and fill the can with water.
5. Stand approximately 2 meters from the catch basin. Toss the can in the upright position into the catch basin. *Hint: You may want a partner to hold the catch basin and maneuver it to ensure a safe landing.
6. Observe the flow of the water as the can flies through the air.
7. Repeat steps 1 through 6 five times. 8. Record observations.

Questions to ponder:
1. What is a force? What forces are considered *Universal Forces?* Why are these called Universal Forces?
2. What force is acting upon the water in the can as it is held above ground?
3. What is Potential Energy? What factors influence the amount of potential energy that an object has?
3. What is Kinetic Energy? What factors influence the amount of kinetic energy that an object has?
4. What type of energy do the can and the water have at this location: potential energy, kinetic energy, or both? Explain your answer.
5. When the can is thrown towards the catch basin, what energy conversion is occurring? Explain your answer for both the can and the water!
6. What does the Law of Conservation of Energy State? Where are you observing this law in this inquiry investigation?
7. What is projectile motion? What forces must combine to produce this type of path?
8. Explain why the flow of water stops as the can falls through the air?
9. What are the similarities and differences between Earth's gravity and the gravity in space? What is the gravity of space referred to as? Why is this term appropriate?
10. Would dropping the can in a direct vertical path produce the same results? Try it and find out!

Graphic Organizer

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
1. An appropriate type of graphic organizer was used to represent the science concepts or processes.				
2. Conceptual information that is displayed within the organizer is scientifically accurate.				
3. Appropriately sized geometric shapes are used throughout to clearly represent science concepts or processes.				
4. Relationships among the geometric shapes are clearly shown with connecting lines.				
5. The eye of the observer is immediately drawn to the topic and main supporting concepts.				
6. There is a natural flow and order to the graphic organizer that allows for easy interpretation by others.				
7. A variety of graphic features such as different textures, shapes, and colors are used to highlight information and enhance the organizer's effectiveness.				
8. Relationships shown among the concepts are accurate and relevant to the topic.				
9. The organizer is neatly drawn, legible, and attractive.				

O Comments O Goals O Actions

Toys in Space

Standards Statements:
3.1.7.A – Explain the parts of a simple system and their relationships to each other.
3.4.7.C – Identify and explain principles of force and motion.

National Standards:
- Understands the law of conservation of energy.
- Understands general concepts related to gravitational force

Content Objectives:
Students will be able to:
1. Explain the role of gravity in the operation of toys.
2. Explain the forces necessary for proper functioning of the toy.
3. Determine if these toys will operate in a microgravity environment.
4. Explain the energy conversions that take place in the functioning of the toys.

Process Objectives:
Students will be able to:
1. Create a hypothesis concerning the functioning of these toys in space.
2. Prepare an oral presentation to demonstrate the role of gravity in the operation of a toy.

Assessment Strategies:
1. Oral presentation explaining the role of forces and gravity in the function of a toy.
2. Written explanation about the operation of the toy in a space environment.
3. Creation of a diagram illustrating the forces acting upon a toy on Earth in comparison to the space environment.

Procedures:
1. Introduce ideas of acceleration, gravity, friction, potential energy, and kinetic energy.
2. Create a word web explaining all of these ideas in relation to Forces and Motion and the affects of these on the function of toys.

Suggested Level:
Intermediate/Secondary

Standard Categories:
3.1 – Unifying Themes
3.4 – Physical Science, Chemistry, and Physics

Materials:
Variety of toys affected by gravity such as:
- Yo-yo
- Center of gravity bird
- Air gun with foam darts
- Paddle ball
- Foam balls
- Chinese yo-yo
- Magnetic metal roller

Instructional Strategies:
Cooperative Learning
Inquiry
Discussion

Related Concepts:
Hypothesizing
Observing
Written Communication
Scientific Drawing

Toys in Space

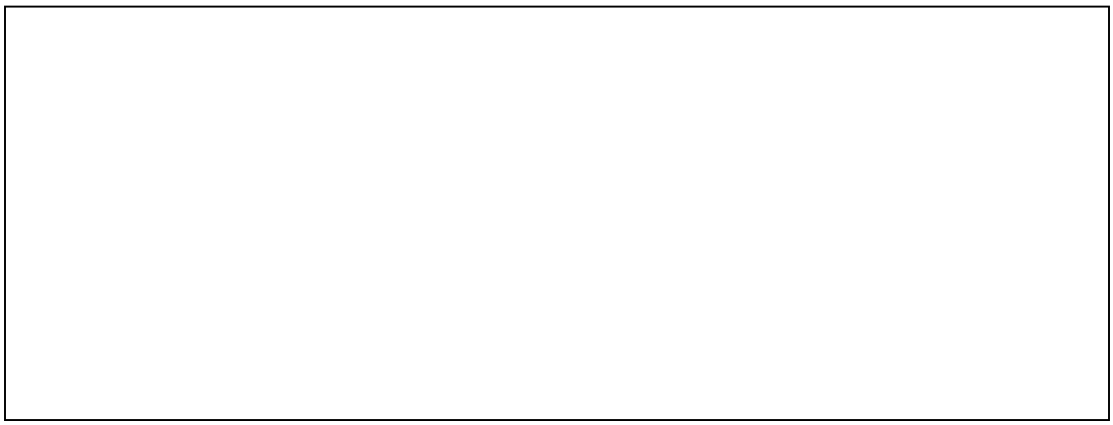
An inquiry activity will be used to investigate the role of gravity in the functioning of toys.

Thought questions to begin:
Will toys work the same in space as they do on earth?
What do you think changes about their behavior in a reduced gravity environment?
What are the reasons for your beliefs?

Investigation:
To investigate the role of gravity in the operation of toys, follow the following instructions carefully:
1. Obtain one toy from your instructor.
2. Within your group discuss the various forces acting upon the toy during its operation.
3. Create a diagram in the space labeled Diagram 1. Label and explain the various forces acting upon your toy as it operates on Earth. Write an explanation in the space provided.
4. Hypothesize how your toy would behave in a space environment. Write an explanation in the space provided.
5. Create a diagram in the space labeled Diagram 2. Label and explain the various forces acting upon your toy as it would operate in space.
6. Exchange toys with another group. Repeat steps 2 through 5, creating diagrams for toy #2 in the spaces provided. Explain the functioning of this toy in the spaces provided.
7. Respond to the "Questions to ponder." Prepare an oral presentation explaining the role of forces and gravity in the operation of your toy. Use a diagram to assist you in your presentation.

Questions to ponder:
1. What is a force? What forces are most instrumental in the functioning of these toys?
2. What is friction? Explain Sliding Friction, Rolling Friction, and Fluid Friction. What type is most evident in the operation of your toy?
3. How does the acceleration caused by gravity affect the performance of your toy?
4. What determines the strength of the force of gravity?
5. Is their gravitational acceleration present in a space environment? Describe this force as it exists in space? What do will call this type of environment?
6. What is responsible for this gravitational acceleration?
7. Is this attraction more or less than that of Earth's? Why?
8. How would this influence the performance of your toy?
9. Do you think that your toy would work in space? Why or why not?

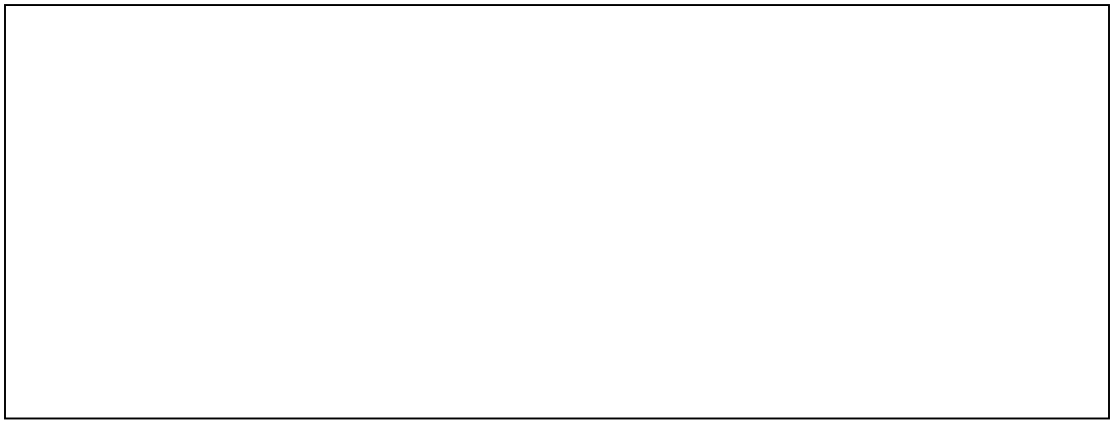
DIAGRAM 1: Forces acting upon _____while on Earth



Toy #1: _____ Explanation of the role of gravity in toy operation

_____
_____
_____
_____
_____

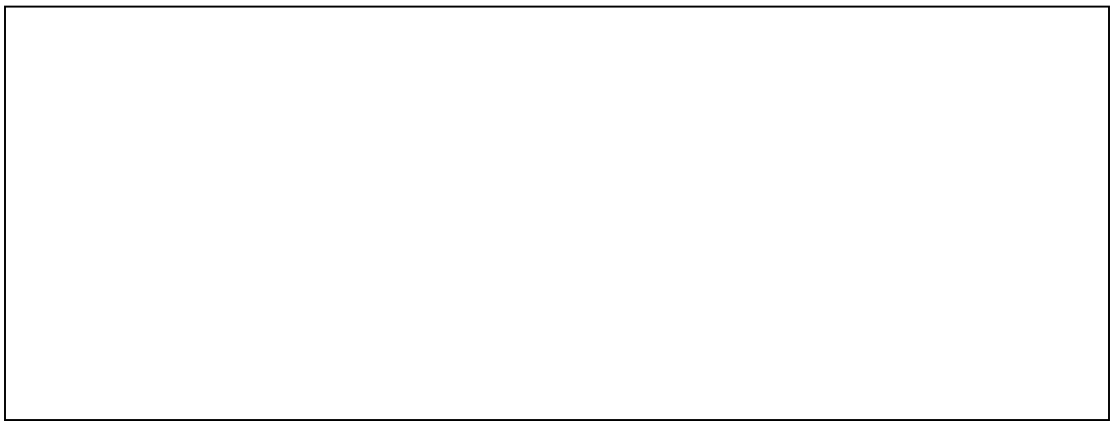
DIAGRAM 2: Forces acting upon _____while in space.



Toy #1: _____ Explanation of operation of toy in microgravity

_____
_____
_____
_____
_____

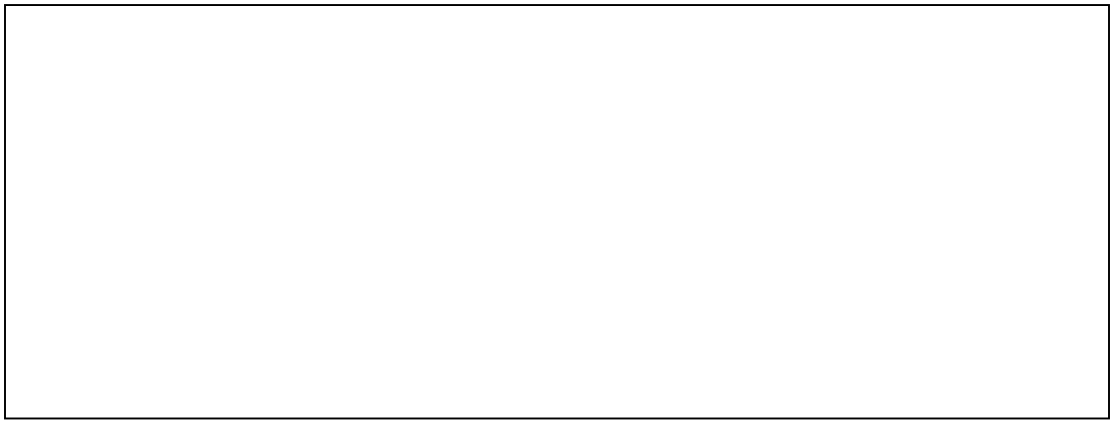
DIAGRAM 3: Forces acting upon _____while on Earth



Toy #2: _____ Explanation of the role of gravity in toy operation

_____
_____
_____
_____
_____

DIAGRAM 4: Forces acting upon _____while in space.



Toy #2: _____ Explanation of operation of toy in microgravity

_____
_____
_____
_____
_____

Scientific Drawing

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
1. The drawing(s) realistically depicts the object(s).				
2. The drawing includes only those features that were actually observed and not inferred.				
3. Many relevant details are included: size (with metric measurements), colors, textures, shapes, and relationships to surroundings.				
4. Multiple perspectives are drawn to provide the viewer with a complete picture of the structures under study.				
5. A descriptive and accurate title is provided for the drawing(s).				
6. All the parts of the scientific drawing are clearly and accurately labeled.				
7. A detailed, written explanation of what the scientific drawing is intended to show is included.				
8. A key or legend, if needed to explain the drawing(s), is provided.				
9. The scientific drawing(s) is of an appropriate size and scale for details to be easily recognized.				
10. A very precise scale and proportion is used consistently. The scale is stated and uses the metric system when possible.				

Scientific Drawing (continued)

Performance Criteria	**Assessment**			
	Points	**Self**	**Teacher**	**Other(s)**
11. The principles of artistic composition are well employed in this drawing.				

O Comments O Goals O Actions

Oral Presentation in Science

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
Content and Organization				
1. The purpose of the presentation (informing, persuading or both), the subject, and any position taken by the presenter are clearly defined at the outset.				
2. The presentation is made in an interesting, logical sequence – an introduction, an organized body, and a clear closure – that the audience can follow.				
3. The introduction has a strong purpose statement that serves to captivate the audience and narrow the topic.				
4. An abundance of accurate supporting scientific concepts, facts, figures, statistics, scenarios, stories, and analogies are used to support the key points and ideas.				
5. The vocabulary is appropriate to both the science content and the audience.				
Optional				
6. Interesting and colorful audiovisuals aids or multimedia materials are interwoven to explain and reinforce the screen text and presentation.				
7. The topic is developed completely and thoroughly.				

Oral Presentation in Science (continued)

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
Presentation				
8. The speaker maintains a proper volume, clear elocution, steady rate, effective inflections and enthusiasm throughout the presentation.				
9. Humor is used positively and in good taste, with consideration given to the composition of the audience.				
10. Stories and motivational scenarios are used appropriately.				
11. Body language such as eye contact, posture, gestures, and body movements are appropriate and are used to create effect.				
12. Delivery is well paced, flows naturally, has good transitions, and is coherent.				
13. The speaker is relaxed, self-confident and appropriately dressed for purpose or audience.				
Audience				
14. The audience's attention is maintained by involving them in the presentation.				
15. Information needed by audience to fully understand the presentation is provided.				
16. The speaker gives the audience time to think, reflect, and ask questions about points made in the presentation.				
17. The speaker answers all questions with clear explanations and further elaborations.				

Oral Presentation in Science (continued)

Performance Criteria	Assessment			
	Points	Self	Teacher	Other(s)
18. The topic and the length of the presentation is appropriate for the audience and within the allotted time limits.				

O Comments O Goals O Actions

What are the effects of gravity on fluids in the human body?

Standards Statements:
3.1.7.E – Identify change as a variable in describing natural and physical systems.
3.4.7.D – Describe essential ideas about the composition of the universe and the earth's place in it.
National Standard:
- knows that when a force is applied to an object, the object either speeds up, slows down, or goes in a different direction.
Content Objectives:
Students will be able to:
1. Explain the affect of gravity on fluids in the human body.
2. Determine the impact of gravity changes on fluids in the human body..
3. Explain potential long term consequences of a reduced gravity environment on the function of the human body.
4. Measure using appropriate scientific units and create a graph of data.
5. Calculate percent change.
Process Objectives:
Students will be able to:
1. Create a hypothesis concerning the affects of gravity changes on fluids in the human body.
2. Write a scientific explanation of the observed effects of gravity changes on the human body.
Assessment Strategies:
1. Graphing of scientific data.
2. Written explanation of the affects of gravity change on fluids in the human body.
Procedures:
1. Introduce idea of gravity with focus on the fluids in the human body.
2. Explain laboratory procedure which will be used to investigate the impact of gravity on fluids in the body.

Suggested Level:
Intermediate/Secondary

Standard Categories:
3.1 – Unifying Themes
3.4 – Physical Science, Chemistry, and Physics

Materials:
Metric tape measure
- if unavailable use standard measure and introduce conversion factor: 1in = 2.54cm

Washable Marker
Table
Wooden blocks
Temperature Strips
Stop Watch
Graph Paper

Instructional Strategies:
Cooperative Learning
Discussion

Related Concepts:
Hypothesizing
Observing
Written Communication
Measuring
Calculating Percent
Graphing

What are the affects of gravity on fluids in the human body?

A laboratory investigation to explore the impact of gravity changes on fluids in the human body.

Thought questions to begin:
What impact does gravity have on the fluids within your body?
What impact will changing the direction of the force of gravity have on the flow of fluids in your body?
What do you expect to happen to the body as a result of a gravity change?

Investigation:
To investigate the role of gravity on the fluids in the human body, follow the following instructions carefully:
1. Measure the circumference of the mid-calf of a volunteer student while the student is standing. Carefully mark the placement of the tape measure with a marker.
2. Record this measurement in Data Table 1.
3. Place a temperature strip on the volunteer's forehead and record this data in Data Table 1.
4. Allow the student to lie down on a lab table.
5. Observe the student to "rest" for five minutes. Data should be collected from the student concerning the sensations felt in the head and upper body.
6. After five minutes measure the student's calf in the exact location as the previous measurement. Record all data collected during investigation. Measure the body temperature of the student volunteer and record data.
7. Repeat step six (6) at five minute intervals for 25 minutes being careful to record all observations.
8. Respond to "questions to ponder."
8. Construct a graph representing change in circumference over time. Time, the independent variable, should be placed on the x-axis
9. Construct a graph representing temperature changes over time.
10. Write a written explanation describing why fluid shift takes place in the human body and the impacts that this has on the human body.

Questions to ponder:
1. What is a force? What force affects the fluid flow in the human body?
2. When lying on a table, what is changed about the forces acting on the body, the size or the direction of the force of gravity? Explain.
3. What impacts of gravity can you observe on your body after a long day on your feet?
4. What changes on the body did you observe as a result of the change in gravity?
5. What long term difficulties and/or consequences might result from gravity change on the human body?
6. What might be done to counteract these difficulties?
7. What might a human living in space experience as a result of reduced gravity? How might this affect the quality of life of humans living in a space environment?

Data Table 1: Gravity and the human body

Time (minutes)	Mid-calf Circumference (cm)	Temperature (^{o}C)	Reported Sensation in head/upper body of subject

Gravity and the Human Body

Measuring Scientifically

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
1. Appropriate tools, techniques, and metric units were selected and used effectively for making measurements.				
2. Measuring techniques were practiced and refined before final measurements were recorded.				
3. Careful measurements were taken in order to minimize systematic measurement error.				
4. The set of measurements is recorded in an organized way (list, table, or chart) so that patterns in the data can easily be discerned.				
5. All measurements are clearly labeled with an appropriate magnitude (numerical value) and unit.				
6. Measurements are reported to the correct number of significant figures.				
7. Alternative strategies, techniques, and measuring tools for improving measurements were examined and discussed.				
8. Multiple measurements were repeated to insure accuracy.				

O Comments O Goals O Actions

Graphing Scientific Data

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Expert 4	An appropriate type of graph was expertly used for the data set(s). The title of the graph clearly relates to the data displayed and reflects both the independent and dependent variables. Physical intervals on the graph are scaled appropriately and spaced evenly. All the parts of the graph are clearly and accurately labeled The set of data is plotted on the graph completely and accurately and the slope of the relationship is indicated. Colors, textures, labels, or other features are used to enhance the graph.
Proficient 3	An appropriate type of graph was used for the data set(s). The title of the graph relates to the data displayed and reflects both the independent and dependent variables. Physical intervals on the graph are scaled appropriately and spaced evenly. Most parts of the graph are clearly and accurately labeled. The set of data is plotted, with only minor errors. Colors, textures, labels, or other features are used to enhance the graph.
Emergent 2	An appropriate type of graph was used for the data set(s). The title of graph relates somewhat to the data displayed, but does not reflect both the independent and dependent variables. Physical intervals on the graph are scaled appropriately and spaced evenly. Some confusion exists as to labeling the parts of the graph. The set of data is plotted, with some errors. There is minimal use of colors, textures, labels, or other features to enhance the graph.
Novice 1	An inappropriate type of graph was used for the data set(s). The title of graph vaguely relates to the data displayed and does not reflect both the independent and dependent variables. Major problems exist with labeling the axes with an appropriate sequence of numbers based upon the range of the data. Physical intervals on the graph are not scaled appropriately nor spaced evenly. Much confusion exists as to labeling the parts of the graph. The set of data is plotted, with many errors. There is little, if any, use of colors, textures, labels, or other features to enhance the graph.

O Comments O Goals O Actions

Writing to Inform in Science (Extended Constructed Response)

Name _____ Date _____ Course/Class _____

Task/Assignment _____

	Development	Organization	Audience	Language
Weights →				
Expert 4	Development: The writer provides accurate, specific, and purposeful scientific facts and concepts that are extended and expanded to fully explain the topic.	Organization: The writer establishes an organizational plan and consistently maintains it.	Audience: The writer provides scientific information relevant to the needs of the audience.	Language: The writer consistently provides scientific vocabulary and language choices to enhance the text.
Proficient 3	Development: The writer provides scientific facts and concepts that adequately explain the topic with some extension of ideas. The information is usually accurate and purposeful.	Organization: The writer establishes and maintains an organizational plan, but the plan may have some minor flaws.	Audience: The writer provides information most of which is relevant to the needs of the audience.	Language: The writer frequently provides scientific vocabulary and uses language choices to enhance the text.
Emergent 2	Development: The writer provides scientific facts and concepts that inadequately explain the topic. The information is sometimes inaccurate, general, or extraneous.	Organization: The writer generally establishes and maintains an organizational plan.	Audience: The writer provides some information relevant to the needs of the audience.	Language: The writer sometimes provides scientific vocabulary and uses language choices to enhance the text.
Novice 1	Development: The writer provides insufficient scientific facts and concepts to explain the topic. The information provided may be vague or inaccurate.	Organization: The writer either did not establish an organizational plan or, if an organizational plan is established, it is only minimally maintained.	Audience: The writer did not provide information relevant to the needs of the audience.	Language: The writer seldom, if ever, provides scientific vocabulary and uses language choices to enhance the text.

How much do I weight in Space?

Standards Statement:
3.1.7.E – Identify change as a variable in describing natural and physical systems.
3.4.7.D – Describe essential ideas about the composition of the universe and the earth's place in it.
National Standard:
- Knows the relationship between the strength of a force and its affect on an object.
Content Objective:
Students will be able to:
1. Explain the factors that determine gravity.
2. Explain the relationship between mass and weight.
3. Describe why gravity is a "Universal Force."
4. Calculate their weight for a variety of locations in the universe.
5. Explain Newton's Law of Universal Gravitation.
6. Create a bar graph displaying weight changes throughout the universe.
Process Objective:
Students will be able to:
1. Create hypotheses concerning the pull of gravity at other locations in universe.
2. Predict values of gravity based on objects mass.
Assessment Strategies:
1. Oral presentation on planet**.**
2. Weight calculations.
3. Written responses to questions
4. Graph of weight calculations.
Procedures:
1. Introduce concepts of mass, weight, and Newton's Law of Universal Gravitation.
2. Discuss the factors that determine the force of gravity.

Suggested Level:
Intermediate/Secondary

Standard Category:
3.1 – Unifying Themes
3.4 – Physical Science, Chemistry, and Physics

Materials:
Scale

Instructional Strategies:
Discussion
Inquiry
Cooperative Learning

Related Concepts:
Hypothesizing
Predicting
Oral Communication
Written Communication
Measuring
Calculating
Graphing

3. Assign students to 10 groups for study of Mercury, Venus, Mars, Jupiter, Uranus, Neptune, Pluto, the Earth's Moon, and the Sun.
4. Allow students to investigate the planets, Moon, and Sun, with emphasis on gravitational pull.
5. Allow students to report their findings to the class.
6. Distribute activity sheet and explain procedure.
7. Allow students to measure weight on Earth, perform calculations, and create graph of weight on Earth and other locations in universe.

How much do I weigh in Space?

An investigation to determine the relationship between the mass, gravity, and weight.

Thought questions to begin:
What impact does gravity have on weight?
How do you expect gravity changes to affect your mass? Weight?
What other observations might you make if living in an environment with more or less gravity?

Investigation:
To investigate the relationship between gravity and weight, follow the following instructions carefully:
1. Carefully weigh yourself on a scale. Record your weight. Repeat the measurement two more times. Calculate the average of these measurements.
2. Using the values indicated in the table calculate your weight at a variety of locations in the universe. Show all of your calculations in the space provided.
3. Construct a graph displaying your weight changes as you travel through the universe.
4. Respond to "questions to ponder."

Questions to ponder:
1. Describe the relationship between mass and weight?
2. What factors determine the force of gravity?
3. Can your weight change as you travel to a variety of locations on Earth? Explain.
4. Based on your observations, where in the universe would you have the most weight? Why?
5. Which location in the universe has the most mass? How do you know?
6. Which location in the universe has the least mass? How do you know?
7. Why is gravity considered a universal force?
8. Explain Newton's Law of Universal Gravitation.

Data Table 1: Weight on Earth in pounds

Trial 1	
Trial 2	
Trial 3	
Average	

Data Table 2: Weight at Locations in Universe

Location in Universe	Gravitational Force	Calculations	Weight (lbs)
Earth	**1g**		
Mercury	**.39g**		
Venus	**.91g**		
Mars	**.38g**		
Jupiter	**2.6g**		
Saturn	**1.1g**		
Uranus	**.88g**		
Neptune	**1.14g**		
Pluto	**.05g**		
Moon	**.167g**		
Sun	**24.1g**		
Microgravity (μg) in Shuttle	**0.000001g**		
Zero Gravity	**0g**		

Measuring Scientifically

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
1. Appropriate tools, techniques, and metric units were selected and used effectively for making measurements.				
2. Measuring techniques were practiced and refined before final measurements were recorded.				
3. Careful measurements were taken in order to minimize systematic measurement error.				
4. The set of measurements is recorded in an organized way (list, table, or chart) so that patterns in the data can easily be discerned.				
5. All measurements are clearly labeled with an appropriate magnitude (numerical value) and unit.				
6. Measurements are reported to the correct number of significant figures.				
7. Alternative strategies, techniques, and measuring tools for improving measurements were examined and discussed.				
8. Multiple measurements were repeated to insure accuracy.				

O Comments O Goals O Actions

Graphing Scientific Data

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Expert 4	An appropriate type of graph was expertly used for the data set(s). The title of the graph clearly relates to the data displayed and reflects both the independent and dependent variables. Physical intervals on the graph are scaled appropriately and spaced evenly. All the parts of the graph are clearly and accurately labeled The set of data is plotted on the graph completely and accurately and the slope of the relationship is indicated. Colors, textures, labels, or other features are used to enhance the graph.
Proficient 3	An appropriate type of graph was used for the data set(s). The title of the graph relates to the data displayed and reflects both the independent and dependent variables. Physical intervals on the graph are scaled appropriately and spaced evenly. Most parts of the graph are clearly and accurately labeled. The set of data is plotted, with only minor errors. Colors, textures, labels, or other features are used to enhance the graph.
Emergent 2	An appropriate type of graph was used for the data set(s). The title of graph relates somewhat to the data displayed, but does not reflect both the independent and dependent variables. Physical intervals on the graph are scaled appropriately and spaced evenly. Some confusion exists as to labeling the parts of the graph. The set of data is plotted, with some errors. There is minimal use of colors, textures, labels, or other features to enhance the graph.
Novice 1	An inappropriate type of graph was used for the data set(s). The title of graph vaguely relates to the data displayed and does not reflect both the independent and dependent variables. Major problems exist with labeling the axes with an appropriate sequence of numbers based upon the range of the data. Physical intervals on the graph are not scaled appropriately nor spaced evenly. Much confusion exists as to labeling the parts of the graph. The set of data is plotted, with many errors. There is little, if any, use of colors, textures, labels, or other features to enhance the graph.

O Comments O Goals O Actions

The Earth is a Giant Magnet

Standards Statement:
3.1.7.B – Describe and use models as an application of scientific or technological concepts.
3.1.7.E – Identify change as a variable in describing natural and physical systems.
3.2.7.A – Explain and apply scientific and technological knowledge.
National Standard:
- Know that magnets attract and repel each other and attract certain kinds of other materials.
Content Objective:
Students will be able to:
1. Explain the force of magnetism as it relates to Earth
2. Describe the forces of attraction and repulsion.
3. Describe why magnetism is a "Universal Force."
4. Explain the reason for constructing the shuttle of a nonmagnetic material.
Process Objective:
Students will be able to:
1. Create hypotheses concerning effect of the Earth's magnetic field on object entering the magnetosphere.
2. Predict the impact of magnetic objects on charged particles within Earth's magnetosphere.
Assessment Strategies:
1. Scientific Drawing.
2. Scientific Observation.
3. Written response to questions.
Procedures:
1. Introduce ideas of magnetism, Earth's Magnetosphere, lines of force, poles, magnetic field, magnetic domains, and magnetic materials.
Information available at:
www.liftoff.msfc.nasa.gov/academy/space/mag_field.html

Suggested Level:
Intermediate/Secondary

Standard Category:
3.1 – Unifying Themes
3.2 – Inquiry and Design

Materials:
Bar magnets
Small magnets
Large paper clips
Iron fillings
White paper

Instructional Strategies:
Discussion
Inquiry
Cooperative Learning

Related Concepts:
Observation
Hypothesizing
Predicting
Written Communication
Scientific Drawing

The Earth is a Giant Magnet
An investigation to explore the affects of magnetic fields on magnetic metals.

Thought questions to begin:
What affects do magnets have on charged particles?
What materials would you use to construct a space shuttle? What properties do these materials possess that contributed to your choices?

Investigation:
To investigate the force of magnetism and its impact on magnetic metals follow the following instructions carefully:
1. Obtain a bar magnet. This will be used to represent the Earth as a magnet.
2. Place a sheet of white paper on your desk. Place your bar magnet in the middle of this paper.
3. Carefully sprinkle iron fillings around your bar magnet. Record your observations in the space provided.
4. Create a scientific drawing of your magnet and fillings. Carefully label the poles and the magnetic field. Label the area where the magnetic field is strongest and weakest.
5. Obtain a second smaller magnet. Carefully slide this magnet perpendicularly into the magnetic field of the first magnet.
6. Record your observations in the space provided. Create a scientific drawing of these magnets and fillings. Be careful to label all areas of significance.
7. Remove the second magnet. Move bar magnet around to recreate "lines of force."
8. Obtain a paper clip. Uncoil the clip. Slide the paper clip perpendicularly into the magnetic field of the bar magnet. Record all observations and create a scientific drawing of your observations.
9. Remove the paper clip. Carefully stroke the clip in one direction with a bar magnet. Carefully slide the clip into the magnetic field of the bar magnet. Record all observations and create a scientific drawing of your observations.

Questions to ponder:

1. Why can the Earth be referred to as a dipole?
2. What are the designations for the ends of a magnet?
3. What are magnetic field lines of force? Where do they originate?
4. What areas of a magnet attract? Repel?
5. Based on your observations, what would happen if a magnetic metal was moving through the Earth's magnetic field?
6. What is the composition of the Earth's core? Are these materials magnetic? How do you think that the movement within the core impacts the Earth's magnetic field?
7. Why is magnetism considered a universal force?
8. What did you observe as you sprinkled iron fillings around your magnet?
9. What did you notice about the lines of force that formed around the poles of your magnet? How did the concentration compare to the iron fillings in the center of the magnet?
10. What does this indicate about the strength of the magnetic forces? Where is this force the strongest? The weakest?
11. Would you direct a space shuttle to return to the Earth at a location close to a magnetic pole? Explain your reasoning.
12. If the iron fillings represent the charged particles in the Earth's atmosphere, what would a magnetic object entering the atmosphere create?
13. What is a magnetic domain? What types of materials are magnetized?
14. What can you do to magnetize an un-magnetized material? Do you think that this process will work on all matter? Explain your reasoning.
15. Would astronauts be able to use a compass to navigate their direction? Explain.

Observation #1: Bar magnet and iron fillings

Scientific Drawing #1: Bar magnet and iron fillings

Observation #2: Magnet entering magnetic field of bar magnet

Scientific Drawing #2: Magnet entering magnetic field of bar magnet

Observation #3: Un-magnetized paper clip entering magnetic field of bar magnet

Scientific Drawing #3: Un-magnetized paper clip entering field of bar magnet

Observation #4: Magnetized paper clip entering magnetic field of bar magnet

Scientific Drawing #4: Magnetized paper clip entering magnetic field of bar magnet

Scientific Drawing

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Expert 4	The drawing(s) realistically and effectively depicts the object(s). Multiple perspectives are provided to enhance understanding. A descriptive and accurate title is provided and all the parts of the drawing are clearly labeled. A detailed, written explanation of what the scientific drawing is intended to show is included, along with a key or legend to further explain the drawing(s). The drawing(s) is of an appropriate size and consistent metric scale for details to be easily recognized. . Principles of artistic composition are well employed.
Proficient 3	The drawing(s) depicts the object(s). Many details are included. A descriptive and accurate title is provided and most parts of the drawing are clearly and neatly labeled. A sketchy, written explanation of what the scientific drawing is intended to show is included. The drawing(s) is of an appropriate size and scale for details to be easily recognized. Principles of artistic composition are employed.
Emergent 2	The drawing(s) reasonably depicts the object(s). The drawing(s) is a reasonable rendition of the object(s), but may include features that were not actually observed. Some details are included. Only one perspective of the object(s) is provided. A title is provided for the drawing(s). Some parts of the scientific drawing are labeled. Labeling lacks neatness, legibility, and attractiveness. A sketchy, written explanation of what the scientific drawing is intended to show is included. The drawing(s) is inappropriately sized and scaled. Principles of artistic composition are largely lacking in this drawing(s).
Novice 1	**The drawings are clearly lacking in realism, accuracy, and detail. It is difficult to tell what the drawing(s) represents. Scale and proportion are clearly lacking. Metric measurements are missing. Few distinguishing forms, structures, and details are labeled. Labeling is not consistently neat, legible, and attractive. No attempt is made to provide a title of the drawing(s). The principles of artistic composition are lacking in this drawing.**

O Comments O Goals O Actions

Observing and Inferring in Science

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
1. Observations are based upon what was actually observed and not based upon prior knowledge, personal opinion, observer bias, or inferences.				
2. Appropriate tools and materials were selected, evaluated, and then used to make the final observations.				
3. Appropriate metric measurements are used to describe quantitative observations.				
4. Observations are quantitatively and/or qualitatively accurate.				
5. Both magnitude and units are recorded for quantitative data.				
6. Observations are interpreted by comparing and contrasting objects or events.				
7. Inferences are explained and justified based upon background research, investigative data, and /or the observer's prior knowledge.				
8. Inferences fall within a range of acceptance (reasonableness) as based upon all the observations, data, and the observer's prior experience.				

O Comments O Goals O Actions

Writing to Inform in Science (Extended Constructed Response)

Name _____ Date _____ Course/Class _____

Task/Assignment _____

	Development	Organization	Audience	Language
Weights →				
Expert 4	Development: The writer provides accurate, specific, and purposeful scientific facts and concepts that are extended and expanded to fully explain the topic.	Organization: The writer establishes an organizational plan and consistently maintains it.	Audience: The writer provides scientific information relevant to the needs of the audience.	Language: The writer consistently provides scientific vocabulary and language choices to enhance the text.
Proficient 3	Development: The writer provides scientific facts and concepts that adequately explain the topic with some extension of ideas. The information is usually accurate and purposeful.	Organization: The writer establishes and maintains an organizational plan, but the plan may have some minor flaws.	Audience: The writer provides information most of which is relevant to the needs of the audience.	Language: The writer frequently provides scientific vocabulary and uses language choices to enhance the text.
Emergent 2	Development: The writer provides scientific facts and concepts that inadequately explain the topic. The information is sometimes inaccurate, general, or extraneous.	Organization: The writer generally establishes and maintains an organizational plan.	Audience: The writer provides some information relevant to the needs of the audience.	Language: The writer sometimes provides scientific vocabulary and uses language choices to enhance the text.
Novice 1	Development: The writer provides insufficient scientific facts and concepts to explain the topic. The information provided may be vague or inaccurate.	Organization: The writer either did not establish an organizational plan or, if an organizational plan is established, it is only minimally maintained.	Audience: The writer did not provide information relevant to the needs of the audience.	Language: The writer seldom, if ever, provides scientific vocabulary and uses language choices to enhance the text.

Magnet Wars!

Standards Statements:
3.2.7.B – Apply process knowledge to make and interpret observations.
3.4.10.C – Distinguish among the principles of force and motion.
National Standard:
- Know that magnets attract and repel each other and attract certain kinds of materials.
- Knows the relationship between the strength of a force and its affect on an object.
Content Objectives:
Students will be able to:
1. Explain the causes of magnetic fields.
2. Explain factors that determine magnetic field strength.
3. Compare the magnetic field of a magnet to the magnetic field of Earth.
Process Objectives:
Students will be able to:
1. Neatly record and organize observations.
2. Communicate with others concerning a magnetic forces.
Assessment Strategies:
1. Neatly organizing and recording of observations collected magnet wars.
2. Written explanation addressing factors that determine magnetic field strength.
3. Obtain accurate measurements with appropriate number of significant figures.
Procedures:
1. Introduce Magnetism.
Use "Magnetism" information found at:
http://www-istp.gsfc.nasa.gov/Education/Imagnet.html
2. Collectively brainstorm factors that determine strength of magnetic force.
3. Introduce the challenge: Who will win the magnet war?
4. Distribute magnets to pairs of students and allow the investigation to begin.

Suggested Level:
Intermediate/Secondary

Standard Categories:
3.2 – Inquiry and Design
3.4 – Physical Science, Chemistry, and Physics

Materials:
Variety of magnets
Iron fillings
White paper
Triple-beam balance

Instructional Strategies:
Cooperative Learning
Inquiry
Discussion

Related Concepts:
Organization
Communication Skills
Objective Observation
Prediction
Measurement

Magnet Wars!

An inquiry activity to investigate the force of magnetism.

Thought questions to begin:
What affects the strength of magnetic force?
What causes the force of magnetism?

Investigation:
To investigate the impact force of magnetism, follow the following instructions carefully:
1. Obtain 2 magnets per pair of students. (one large and one small) Each student should choose one magnet.
2. Pour iron fillings in a piece of paper and spread them out.
3. Place magnets approximately 5cm from edges of paper. When teacher says go, begin to move your magnets at the same speed onto the paper.
4. Observe the attraction of iron fillings toward the magnets.
5. Stop moving magnets toward each when they are approximately 2.5cm apart.
6. Using a balance, obtain the mass of iron fillings collected by each magnet.
7. Record data and observations in data table.
8. Repeat the war for 4 more trials. Record all data and observations in table.

Questions to ponder:
1. What is the force of magnetism?
2. What factors determine the strength of magnetic force?
3. Based on your observations, what could you do to give the lesser magnet a "head start?"
4. Obtain a compass. Is the strength of your magnet great enough to overcome the magnetic force of the Earth? Explain your observations.

Magnet Wars Data

Description of Magnet 1:

_____
_____
_____

Description of Magnet 2:

_____
_____
_____

Data Table 1

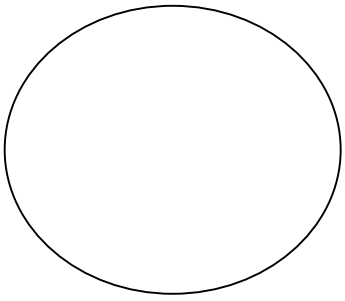
Trial #	Mass collected by Magnet 1 (grams)	Mass collected by Magnet 2 (grams)	Winner!
1			
2			
3			
4			
5			

Based on your observations, what determined the strength of the magnetic force?

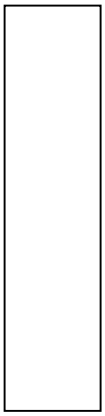
_____
_____
_____
_____
_____

Draw a representation of the magnetic field of Earth and a bar magnet.

Earth



A Bar Magnet



Writing to Inform in Science (Extended Constructed Response)

Name _____ Date _____ Course/Class _____

Task/Assignment _____

	Development	Organization	Audience	Language
Weights →				
Expert 4	Development: The writer provides accurate, specific, and purposeful scientific facts and concepts that are extended and expanded to fully explain the topic.	Organization: The writer establishes an organizational plan and consistently maintains it.	Audience: The writer provides scientific information relevant to the needs of the audience.	Language: The writer consistently provides scientific vocabulary and language choices to enhance the text.
Proficient 3	Development: The writer provides scientific facts and concepts that adequately explain the topic with some extension of ideas. The information is usually accurate and purposeful.	Organization: The writer establishes and maintains an organizational plan, but the plan may have some minor flaws.	Audience: The writer provides information most of which is relevant to the needs of the audience.	Language: The writer frequently provides scientific vocabulary and uses language choices to enhance the text.
Emergent 2	Development: The writer provides scientific facts and concepts that inadequately explain the topic. The information is sometimes inaccurate, general, or extraneous.	Organization: The writer generally establishes and maintains an organizational plan.	Audience: The writer provides some information relevant to the needs of the audience.	Language: The writer sometimes provides scientific vocabulary and uses language choices to enhance the text.
Novice 1	Development: The writer provides insufficient scientific facts and concepts to explain the topic. The information provided may be vague or inaccurate.	Organization: The writer either did not establish an organizational plan or, if an organizational plan is established, it is only minimally maintained.	Audience: The writer did not provide information relevant to the needs of the audience.	Language: The writer seldom, if ever, provides scientific vocabulary and uses language choices to enhance the text.

Measuring Scientifically

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
1. Appropriate tools, techniques, and metric units were selected and used effectively for making measurements.				
2. Measuring techniques were practiced and refined before final measurements were recorded.				
3. Careful measurements were taken in order to minimize systematic measurement error.				
4. The set of measurements is recorded in an organized way (list, table, or chart) so that patterns in the data can easily be discerned.				
5. All measurements are clearly labeled with an appropriate magnitude (numerical value) and unit.				
6. Measurements are reported to the correct number of significant figures.				
7. Alternative strategies, techniques, and measuring tools for improving measurements were examined and discussed.				
8. Multiple measurements were repeated to insure accuracy.				

O Comments O Goals O Actions

What Protects the Astronauts From Extreme Temperature Change in Space?

Standard Statement:
3.4.7 B- Relate energy sources and transfer to heat and temperature**.**

Content Objectives:
Students will be able to:
1. Decide the effectiveness of Mylar, cotton fabric, and gortex for protecting the astronauts from extreme temperature variation in space.

Process Objectives:
Students will be able to:
1. Discuss the advantages and disadvantages of using various materials for the construction of tiles on the outside covering of the space shuttles.
2. Data collection and analysis.

Assessment Strategies:
1. Accurately measure and record thermometer readings to determine temperature changes.
2. Analysis of data collected.
3. Create a poster of a spacesuit design based on the information gathered in lab and information collected on the NASA website.

Procedures:
1. Discuss with students the extreme temperature variation encountered in space due to the lack of atmosphere
2. Have students assemble into lab groups and gather the necessary materials.

Suggested Level:
Intermediate/Secondary

Standard Category:
3.4—Physical Science, Chemistry and Physics

Materials:
Two inch square pieces of Mylar, gortex, and white cotton fabric
White paper
Four thermometers
Heat lamp

Instructional Strategies:
Experimentation
Cooperative learning
Research
Essay writing
Interpreting data

Related Concepts:
Understanding the space environment

What Protects Astronauts From Extreme Temperature Change in Space?

Thought question to begin:
What types of materials do you wear to keep cool in the summer? _____

Investigation:
To decide which materials would be best suited for the construction of space suits, conduct the following investigation.

1. Place the three pieces of material in a row on a sheet of white paper so they are evenly spaced.
2. Insert a thermometer behind each of the pieces of material.
3. Tape the edges of each material to the paper so they stay in place.
5. Record the initial temperature from each of the thermometers in the data table.
6. Turn on the heat lamp and begin evenly heating each of the material samples, recording the temperature of each every five minutes for thirty minutes.
7. Place all materials back in their proper locations and clear the lab area.

Data Table:

Time (minutes)	Temperature of Mylar (°C)	Temperature of Cotton (°C)	Temperature of gortex (°C)
0			
5			
10			
15			
20			
25			
30			

Questions to ponder:

1. Which material had the greatest change in temperature? Which had the least?
2. Which materials would be best suited for use in the fabric of a spacesuit? Why?
3. Which material if any would not be well suited for space suit fabric to reduce temperature change?
4. Would the color of the materials have any affect on their ability to protect the astronauts from extreme temperature change?
5. Do you think the astronauts need more protection from extreme temperature change than can be given from one layer of material in a spacesuit?
6. What other factors would NASA have to consider before deciding on materials for a spacesuit?
7. Do you think spacesuits are made from one material or layers of different materials that serve different purposes to protect the astronauts?
8. What other materials and devices would you add to a spacesuit to protect the astronauts from the harsh conditions they may encounter in outer space?

Follow up Activity:

1. Design a poster describing how you would construct a spacesuit for the astronauts to wear during their space walks outside the shuttle. Research information on the NASA website on other extreme conditions the astronauts face while in space. Take these factors into account when you design your suit. Present your poster to your class.

Poster

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
1. The poster contains a title that clearly reflects the topic or theme.				
2. The poster contains relevant and accurate information about the topic or theme.				
3. The format of the poster is appropriate to the content, purpose, and audience for which it is designed.				
4. Graphic elements, such as pictures, photographs, charts, tables, scientific drawings, diagrams, graphs, etc., add to the overall effectiveness of the poster				
5. There is a coherent, flowing organization to the poster with the various elements (text, graphics, etc.) working well together.				
6. The poster is aesthetically pleasing, with effective use of space, color, texture, and shape.				
7. The poster is skillfully designed and crafted using appropriate graphic design tools				
8. The poster effectively communicates its theme in convincing fashion to the intended audience.				
9. The poster is creative and draws attention.				
10. Language chosen for the poster is captivating, persuasive, informative, accurate, and concise.				

O Comments O Goals O Actions

Oral Presentation in Science

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
Content and Organization				
1. The purpose of the presentation (informing, persuading or both), the subject, and any position taken by the presenter are clearly defined at the outset.				
2. The presentation is made in an interesting, logical sequence – an introduction, an organized body, and a clear closure – that the audience can follow.				
3. The introduction has a strong purpose statement that serves to captivate the audience and narrow the topic.				
4. An abundance of accurate supporting scientific concepts, facts, figures, statistics, scenarios, stories, and analogies are used to support the key points and ideas.				
5. The vocabulary is appropriate to both the science content and the audience.				
Optional				
6. Interesting and colorful audiovisuals aids or multimedia materials are interwoven to explain and reinforce the screen text and presentation.				
7. The topic is developed completely and thoroughly.				

Oral Presentation in Science (continued)

Performance Criteria	Assessment			
	Points	Self	Teacher	Other(s)
Presentation				
8. The speaker maintains a proper volume, clear elocution, steady rate, effective inflections and enthusiasm throughout the presentation.				
9. Humor is used positively and in good taste, with consideration given to the composition of the audience.				
10. Stories and motivational scenarios are used appropriately.				
11. Body language such as eye contact, posture, gestures, and body movements are appropriate and are used to create effect.				
12. Delivery is well paced, flows naturally, has good transitions, and is coherent.				
13. The speaker is relaxed, self-confident and appropriately dressed for purpose or audience.				
Audience				
14. The audience's attention is maintained by involving them in the presentation.				
15. Information needed by audience to fully understand the presentation is provided.				
16. The speaker gives the audience time to think, reflect, and ask questions about points made in the presentation.				
17. The speaker answers all questions with clear explanations and further elaborations.				

Oral Presentation in Science (continued)

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
18. The topic and the length of the presentation is appropriate for the audience and within the allotted time limits.				

O Comments O Goals O Actions

Scientific Investigation

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Expert 4	The question has been developed in such a way that it can be answered by conducting an experiment and reflects background research and previous observations. The hypothesis has been developed directly from the question and is expertly expressed in an "If-and-then" statement(s). The procedures are detailed, complete, follow a logical step by step order, and include a list of all necessary materials. The experimental design uses proper controls and tests for the effects of only one independent variable at a time. The collected data are organized and displayed in appropriate graphic formats. The data are manipulated through the use of appropriate statistical methods. The conclusions of the experiment are written in clear and complete statements, and are supported by the data. Language used is appropriate, purposeful, and written in complete sentences. Scientific content and terminology are accurate.
Proficient 3	The question provides general guidance to the design of an experiment. The hypothesis has been developed from the question and is expressed in an "If-and-then" statement(s). The procedures are complete, follow a somewhat logical step by step order, and include a list of materials. The experimental design uses proper controls and tests for the effects of only one independent variable at a time. The collected data are organized, displayed, and manipulated through the use of appropriate statistical methods. The conclusions of the experiment are written in clear and complete statements, and are mostly supported by the data. Language used is appropriate and purposeful. Scientific content and terminology may contain minor errors.
Emergent 2	The question provides some guidance to the design of an experiment. The hypothesis is loosely connected to the question and there is an attempt to express it in an "If-and-then" statement(s). The procedures are incomplete and follow a somewhat illogical step by step order. The experimental design does not completely identify nor control variables. The collected data are disorganized and there is limited manipulation through the use of appropriate statistical methods. The conclusions of the experiment are loosely supported by the data. Much of the language used is inappropriate. Scientific content and terminology contains major errors.
Novice 1	The question is ill defined and gives little to no direction for developing an experiment. The hypothesis bears little to no connection to the question. The design of the experiment is unclear. The procedures are confusing and difficult to follow. Variables have not been clearly identified, nor controlled. The conclusions of the experiment are vague, not written in clear and complete statements, and are not supported by the data.

O Comments O Goals O Actions

How does Extreme Temperature Affect Cells?

Standard Statement:
3.3 B- Describe and explain the chemical and chemical basis of living organisms.
3.4.7 A- Describe concepts about the structure and properties of matter.

Content Objectives:
Students will be able to:
1. Identify the affect of extreme temperature change on living cells.
2. Discuss the problems astronauts face while in space relating to extreme temperature variation.
3. Use proper microscope techniques.
4. Discuss how astronauts overcome extreme temperature variations in the space environment.

Process Objectives:
Students will be able to:
1. Prepare microscope slides and focus using the coarse and fine objectives.
2. Draw Samples seem on the microscope slide for comparison.
3. Analyze data collected in an oral presentation.
4. Create a visual aid to be used during the presentation.

Assessment Strategies:
1. Collection of data in the form of visual observations and drawings.
2. Analysis of data collection in an oral presentation using a visual aid.

Procedures:
1. Discuss with students the extreme temperature variation encountered in space due to the lack of atmosphere.
2. Complete the following investigation.

Suggested Level:
Intermediate/Secondary

Standard Category:
3.4-Physical Science, Chemistry and Physics
3.3-Biology Sciences

Materials:
3 onions
Microscope
Tweezers
Microscope slides
Cover slips

Instructional Strategies:
Experimentation
Cooperative learning
Research
Essay writing
Interpreting data

Related Concepts:
Artistic presentation
Understanding the space environment

How Does Extreme Temperature Affect Cells?

Thought question to begin:

What compound makes up 75% of your body? _____

Investigation:

Complete the following investigation to understand the affect of extreme temperature on living cells? Follow the following instructions carefully!

1. On the day before the investigation place one of the onions in the freezer. On the day of the investigation, take the onion out of the freezer and allow it to thaw.

2. Place the other onion in the microwave until it is cooked (approximately 2 minutes) and allow it to cool.

3. Slice each onion into strips lengthwise along the grain to create banana shaped pieces. Observe the texture of the three onions. Record your observations in the data table.

4. Using the tweezers, peel the clear, thin, outer layer of skin from the onion and place it on the microscope slide. Place a drop or two of stain on the onion.

5. Place a cover slip over the onion and place it on the stage of the microscope.

6. Focus on the onion slide under the scanning objective lens (4X).

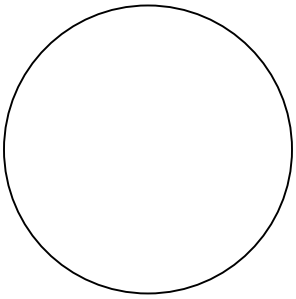
7. Draw the image that you see under the microscope.

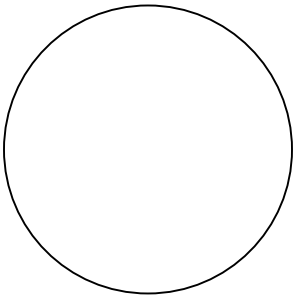
8. Repeat steps 3 through 7 using the cooked and defrosted onion pieces.

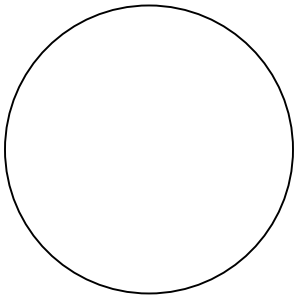
Data Table

Onion	*Texture*
Defrosted	
Cooked	
Standard	

Draw slides below:







Standard ***Cooked*** ***Defrosted***

Questions to ponder:

1. What parts of a plant cell are visible under the microscope?
2. What is the function of the cell wall in the plant cell?
3. Do animal cells have cell walls?
4. Are there any differences in the visual appearances of the three cells? If so please describe them.
5. Of what compound is the majority of the cell composed?
6. Does ice sink or float when it is placed it water?
7. What causes this to happen?
8. Is ice more or less dense than liquid water?
9. What happens to the cell membrane and the vacuoles in a cell as water freezes and takes up more space?
10. What might happen to an animal cell if it were exposed to extreme hot or cold temperatures?
11. What are the implications of these results for astronauts in space?

Follow up activity:

Give an oral presentation about the results of your experiment. Create a visual aid that incorporates the results of your experiment and the information you learned from this lab.

Oral Presentation in Science

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
Content and Organization				
1. The purpose of the presentation (informing, persuading or both), the subject, and any position taken by the presenter are clearly defined at the outset.				
2. The presentation is made in an interesting, logical sequence – an introduction, an organized body, and a clear closure – that the audience can follow.				
3. The introduction has a strong purpose statement that serves to captivate the audience and narrow the topic.				
4. An abundance of accurate supporting scientific concepts, facts, figures, statistics, scenarios, stories, and analogies are used to support the key points and ideas.				
5. The vocabulary is appropriate to both the science content and the audience.				
Optional				
6. Interesting and colorful audiovisuals aids or multimedia materials are interwoven to explain and reinforce the screen text and presentation.				
7. The topic is developed completely and thoroughly.				

Oral Presentation in Science (continued)

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
Presentation				
8. The speaker maintains a proper volume, clear elocution, steady rate, effective inflections and enthusiasm throughout the presentation.				
9. Humor is used positively and in good taste, with consideration given to the composition of the audience.				
10. Stories and motivational scenarios are used appropriately.				
11. Body language such as eye contact, posture, gestures, and body movements are appropriate and are used to create effect.				
12. Delivery is well paced, flows naturally, has good transitions, and is coherent.				
13. The speaker is relaxed, self-confident and appropriately dressed for purpose or audience.				
Audience				
14. The audience's attention is maintained by involving them in the presentation.				
15. Information needed by audience to fully understand the presentation is provided.				
16. The speaker gives the audience time to think, reflect, and ask questions about points made in the presentation.				
17. The speaker answers all questions with clear explanations and further elaborations.				

Oral Presentation in Science (continued)

Performance Criteria	Assessment			
	Points	Self	Teacher	Other(s)
18. The topic and the length of the presentation is appropriate for the audience and within the allotted time limits.				

O Comments O Goals O Actions

Scientific Drawing

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Expert 4	The drawing(s) realistically and effectively depicts the object(s). Multiple perspectives are provided to enhance understanding. A descriptive and accurate title is provided and all the parts of the drawing are clearly labeled. A detailed, written explanation of what the scientific drawing is intended to show is included, along with a key or legend to further explain the drawing(s). The drawing(s) is of an appropriate size and consistent metric scale for details to be easily recognized. . Principles of artistic composition are well employed.
Proficient 3	The drawing(s) depicts the object(s). Many details are included. A descriptive and accurate title is provided and most parts of the drawing are clearly and neatly labeled. A sketchy, written explanation of what the scientific drawing is intended to show is included. The drawing(s) is of an appropriate size and scale for details to be easily recognized. Principles of artistic composition are employed.
Emergent 2	The drawing(s) reasonably depicts the object(s). The drawing(s) is a reasonable rendition of the object(s), but may include features that were not actually observed. Some details are included. Only one perspective of the object(s) is provided. A title is provided for the drawing(s). Some parts of the scientific drawing are labeled. Labeling lacks neatness, legibility, and attractiveness. A sketchy, written explanation of what the scientific drawing is intended to show is included. The drawing(s) is inappropriately sized and scaled. Principles of artistic composition are largely lacking in this drawing(s).
Novice 1	**The drawings are clearly lacking in realism, accuracy, and detail. It is difficult to tell what the drawing(s) represents. Scale and proportion are clearly lacking. Metric measurements are missing. Few distinguishing forms, structures, and details are labeled. Labeling is not consistently neat, legible, and attractive. No attempt is made to provide a title of the drawing(s). The principles of artistic composition are lacking in this drawing.**

O Comments O Goals O Actions

Scientific Investigation

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Expert 4	The question has been developed in such a way that it can be answered by conducting an experiment and reflects background research and previous observations. The hypothesis has been developed directly from the question and is expertly expressed in an "If-and-then" statement(s). The procedures are detailed, complete, follow a logical step by step order, and include a list of all necessary materials. The experimental design uses proper controls and tests for the effects of only one independent variable at a time. The collected data are organized and displayed in appropriate graphic formats. The data are manipulated through the use of appropriate statistical methods. The conclusions of the experiment are written in clear and complete statements, and are supported by the data. Language used is appropriate, purposeful, and written in complete sentences. Scientific content and terminology are accurate.
Proficient 3	The question provides general guidance to the design of an experiment. The hypothesis has been developed from the question and is expressed in an "If-and-then" statement(s). The procedures are complete, follow a somewhat logical step by step order, and include a list of materials. The experimental design uses proper controls and tests for the effects of only one independent variable at a time. The collected data are organized, displayed, and manipulated through the use of appropriate statistical methods. The conclusions of the experiment are written in clear and complete statements, and are mostly supported by the data. Language used is appropriate and purposeful. Scientific content and terminology may contain minor errors.
Emergent 2	The question provides some guidance to the design of an experiment. The hypothesis is loosely connected to the question and there is an attempt to express it in an "If-and-then" statement(s). The procedures are incomplete and follow a somewhat illogical step by step order. The experimental design does not completely identify nor control variables. The collected data are disorganized and there is limited manipulation through the use of appropriate statistical methods. The conclusions of the experiment are loosely supported by the data. Much of the language used is inappropriate. Scientific content and terminology contains major errors.
Novice 1	The question is ill defined and gives little to no direction for developing an experiment. The hypothesis bears little to no connection to the question. The design of the experiment is unclear. The procedures are confusing and difficult to follow. Variables have not been clearly identified, nor controlled. The conclusions of the experiment are vague, not written in clear and complete statements, and are not supported by the data.

O Comments O Goals O Actions

What Protects Astronauts from Radiation in Space?

Standard Statement:
3.4.7 B- Relate energy sources and transfer to heat and temperature.

Content Objectives:
Students will be able to:
1. Determine the function of Mylar in space suits.
2. Determine what characteristics of Mylar make it an affective choice for protecting astronauts in space.

Process Objectives:
Students will be able to:
1. Complete a scientific inquiry to determine the function of a material.
2. Data collection and analysis.

Assessment Strategies:
1. Data collection and analysis of results to draw scientific conclusions.
2. Compose a written report on the results of the experiment.
2. Create a brochure.

Procedures:
1. Discuss with students the various types of electromagnetic radiation emitted from the sun and how the lack of an atmosphere in space exposes the astronauts to dangerous amounts of radiation.
2. Have students complete the following investigation.

Suggested Level:
Intermediate/Secondary

Standard Category:
3.4—Physical Science, Chemistry and Physics

Materials:
Two handheld walkie-talkies
Television with remote control
Sheet of Mylar
Radio with antenna
Flashlight

Instructional Strategies:
Experimentation
Cooperative learning
Research
Interpreting data

Related Concepts:
Understanding the space environment

What Protects Astronauts From Radiation in Space?

Thought question to begin:
What common product is usually made from Mylar? _____

Investigation:
To decide on the effectiveness of Mylar in stopping radiation, complete the following investigation.

1. Give a walkie-talkie to a pair of lab partners.
2. Have a lab partner stand on either side of a doorway and tape a sheet of Mylar between them. Alternately, have a third partner hold a sheet of Mylar between the partners that are holding the walkie-talkies.
3. Try to communicate with each other using the walkie-talkies. Record your results.
4. Repeat the experiment without the sheet of Mylar between the partners. Record your results.
5. Take the sheet of Mylar cover the front end of the remote control from a TV. Try turning on the TV with the remote control. Record your results.
6. Try turning on the TV without the sheet of Mylar over the remote. Record your results.
7. Turn on a radio and set it to a channel with clear reception. Record your results.
8. Wrap a sheet of Mylar around the antenna and listen to the reception. Record your results.
9. Take a flashlight and try shining the light through the sheet of Mylar. Record your results.

Data Table:

Device	**With Mylar**	**Without Mylar**
Walkie-talkies		
TV remote		
Radio		
Flashlight		

Questions to ponder:

1. List the types of radiation in the electromagnetic spectrum.
2. What types of radiation are used to operate each of the devices you used in lab?
3. How did the Mylar affect each of these types of radiation?
4. Is Mylar an affective tool in stopping the types of radiation you tested?
5. What other properties of Mylar make it an ideal material for the astronaut's space suits?

Follow up Activity:

1. Give the results of your lab in a written report.
2. Create a pamphlet on the parts of an astronaut's space suit and the function of each layer of the suit. Present the brochure to the class.

Pamphlet

Name _____ Date _____ Course/Class _____

Task/Assignment _____

Performance Criteria	Assessment			
	Points	**Self**	**Teacher**	**Other(s)**
1. Scientific content is accurate and supports the major sections of the pamphlet.				
2. The format used to layout the pamphlet is effective for the intended audience.				
3. The pamphlet is creative and interesting.				
4. The writing in the pamphlet is objective, clear and concise, has clear sentence structure and uses descriptive rather than figurative language.				
5. The pamphlet has all the following presentation elements: words and visuals are easy to see, titles and headings are easy to distinguish, and colors and patterns in pamphlet are pleasing.				
6. Diagrams, pictures, and other graphics are of quality and add to the overall effectiveness of the pamphlet.				
7. References are included and are correctly cited				
8. There are no errors in the mechanics (spelling and grammar.)				

O Comments O Goals O Actions

Lab Report

Name _____ Date _____ Course/Class _____

Task/Assignment _____

	Title/ Introduction	Background Research	Question/ Problem/ Hypothesis	Procedures	Data & Results	Conclusions	Language Usage
Weights →							
Expert 4	The title states clearly both the independent dependent variables and the results of the experiment. The title of the report is written in a clear declarative statement. The lead-in information is concise and develops a clear understanding of the report to follow. A concise abstract of the lab is provided and does not exceed 250 words. ☐ ☐	Relevant literature and prior observations are cited which provide much insight into the phenomena to be included in the report. ☐ ☐	The question or problem that the lab was designed to answer is well articulated. The hypothesis is eloquently stated in the "If-and-then" format. It predicts the influence of the independent variable on the dependent variable. ☐ ☐	The procedures for controlling and measuring the dependent variable are well defined and clear. A detailed, logical step-by-step set of procedures that were used for conducting the lab is listed. Safety concerns are listed among the procedures. ☐ ☐	Data tables and graphs are expertly and neatly completed and totally accurate. Patterns or trends in data are noted. Data analysis is thorough. ☐ ☐	A response to both the question and hypothesis is clearly and completely provided and is consistent with the data. Limitations and extrapolations of the data are cited. Questions for further study are developed. Unresolved questions and problems are listed. ☐ ☐	Language is used correctly and purposefully. All words are spelled correctly. The report is neat, legible, and presentable. ☐ ☐
Proficient 3	The title states both the independent dependent variables and the results of the experiment. The title of the report is written in a clear declarative statement. The lead-in information is concise and develops a clear understanding of the report to follow. ☐ ☐	Relevant literature and prior observations are cited which provide insight into the phenomena to be included in the report. ☐ ☐	The question or problem that the lab was designed to answer is listed. The hypothesis is stated in the "If-and-then" format. It predicts the influence of the independent variable on the dependent variable. ☐ ☐	The procedures for controlling and measuring the dependent variable are defined and clear. A detailed, logical step-by-step set of procedures that were used for conducting the lab is listed. Safety concerns are missing form the procedures. ☐ ☐	Data tables and graphs neatly completed and totally accurate. Patterns or trends in data are noted. Data analysis is thorough. ☐ ☐	A response to both the question and hypothesis is provided. Some limitations and extrapolations of the data are cited. ☐ ☐	Language is used correctly and purposefully. Some words are misspelled, but with little or no effect upon the final product. The report is neat, legible, and presentable. ☐ ☐

Lab Report (continued)

	Title/ Introduction	**Background Research**	**Question/ Problem/ Hypothesis**	**Procedures**	**Data & Results**	**Conclusions**	**Language Usage**
Emergent 2	The title is stated in a rambling, non-concise fashion. There is an attempt within the title to state both the independent dependent variables and the results of the experiment. The title of the report is written in a declarative statement. The lead-in information lacks conciseness and clarity. ❑ ❑	Literature and prior observations are cited, but provide little insight into the phenomena to be included in the report. ❑ ❑	The question or problem that the lab was designed to answer is ill defined. The hypothesis is stated, but not in the "If-and-then" format. ❑ ❑	Some of the steps are understandable; most are confusing and lack detail. ❑ ❑	Data tables and graphs are completed, but lack accuracy. Patterns or trends within the data are difficult to discern. Data analysis lacks thoroughness. ❑ ❑	Presents an illogical explanation for findings. ❑ ❑	For the most part, language is used correctly. However, many words are misspelled, impacting upon the final product. The report borders on being sloppy, illegible, and not presentable. ❑ ❑
Novice 1	The title is stated in a rambling, non-concise fashion. There is no attempt within the title to state the independent and dependent variables and the results of the experiment. The title of the report is written in a declarative statement. The lead-in information provides little or no information that leads into the report. ❑ ❑	Literature and prior observations are not cited. ❑ ❑	The question or problem that the lab was designed to answer is not defined. There is no hypothesis. ❑ ❑	Not sequential, most steps are missing or are confusing. ❑ ❑	Data tables and/or graphs are missing information and are inaccurate. Consequently, patterns or trends within the data are not discernable. Little attempt is made at data analysis. ❑ ❑	Presents an illogical explanation for findings and does not address the question that guided the lab. ❑ ❑	Language is used incorrectly and without purpose. Many words are misspelled, impacting significantly upon the final product. The report is definitely sloppy, illegible, and not presentable. ❑ ❑

What are Space Shuttle Tiles Made From?

Standard Statement:
3.4.7 A- Describe concepts about the structure and properties of matter.

Content Objectives:
Students will be able to:
1. Determine which material would be better suited for use as space shuttle tiles.
2. Determine if metal or sand is a better conductor of heat.

Process Objectives:
Students will be able to:
1. Discuss the advantages and disadvantages of using various materials for the construction of tiles on the outside covering of the space shuttles.
2. Data collection and analysis.

Assessment Strategies:
1. Data collection of temperature readings under varying conditions.
2. Analysis of data collection in a comprehensive essay based on the results of the experiment and information collected on the NASA website.

Procedures:
1. Discuss with students the extreme temperature variation encountered in space due to the lack of atmosphere. Also discuss how the friction caused by the atmosphere when the shuttle returns to earth causes a need for a highly isolating material to be used to cover the shuttle.
2. Have students assemble into lab groups and gather the necessary materials.

Suggested Level:
Intermediate/Secondary

Standard Category:
3.4—Physical Science, Chemistry and Physics

Materials:
Two, 250 ml beakers.
Aluminum metal pieces
Coarse sand
Two thermometers
Heat lamps

Instructional Strategies:
Experimentation
Cooperative learning
Research
Essay writing
Interpreting data

Related Concepts:
Understanding the space environment

What are space shuttle tiles made from?

Thought question to begin:
Which is a better conductor of heat, metals or nonmetals? _____

Investigation:
To decide which material would be better suited for the exterior of the space shuttle, conduct the following investigation.

1. Place approximately 350ml of sand in a 400ml beaker. In a second 400ml beaker, place the same volume of aluminum shot.
2. Insert a thermometer into each beaker so the bulb of the thermometer is in the middle of the sample. Record the initial temperature of each sample.
3. Place each sample under a heat lamp and record the temperature change in each every 5 minutes for a total of 30 minutes in the data table.
4. Place all materials back in their proper locations and clear the lab area.

Data Table:

Time (minutes)	Temperature of sand (°C)	Temperature of Al (°C)
0		
5		
10		
15		
20		
25		
30		

Questions to ponder:

1. Why is aluminum a better conductor of heat than sand?
2. The tiles that cover the outside of the space shuttle are made from very porous glass, which has been whipped with air so it acts as an insulator to protect the crew inside the shuttle. What is an insulator?
3. Are metals or nonmetals better insulators?
4. What element is the main component of sand?
5. What do sand and glass have in common?

Follow up Activity:

1. You have been placed in charge of the NASA division that will design the space shuttle tiles. In an essay, discuss the results of your experiment and your recommendations for the design and materials for the tiles.
2. Conduct the same experiment using ice to cool the samples over time. Are the results similar?

Lab Report

Name _____ Date _____ Course/Class _____

Task/Assignment _____

	Title/ Introduction	Background Research	Question/ Problem/ Hypothesis	Procedures	Data & Results	Conclusions	Language Usage
Weights →							
Expert 4	The title states clearly both the independent dependent variables and the results of the experiment. The title of the report is written in a clear declarative statement. The lead-in information is concise and develops a clear understanding of the report to follow. A concise abstract of the lab is provided and does not exceed 250 words. ☐ ☐	Relevant literature and prior observations are cited which provide much insight into the phenomena to be included in the report. ☐ ☐	The question or problem that the lab was designed to answer is well articulated. The hypothesis is eloquently stated in the "If-and-then" format. It predicts the influence of the independent variable on the dependent variable. ☐ ☐	The procedures for controlling and measuring the dependent variable are well defined and clear. A detailed, logical step-by-step set of procedures that were used for conducting the lab is listed. Safety concerns are listed among the procedures. ☐ ☐	Data tables and graphs are expertly and neatly completed and totally accurate. Patterns or trends in data are noted. Data analysis is thorough. ☐ ☐	A response to both the question and hypothesis is clearly and completely provided and is consistent with the data. Limitations and extrapolations of the data are cited. Questions for further study are developed. Unresolved questions and problems are listed. ☐ ☐	Language is used correctly and purposefully. All words are spelled correctly. The report is neat, legible, and presentable. ☐ ☐
Proficient 3	The title states both the independent dependent variables and the results of the experiment. The title of the report is written in a clear declarative statement. The lead-in information is concise and develops a clear understanding of the report to follow. ☐ ☐	Relevant literature and prior observations are cited which provide insight into the phenomena to be included in the report. ☐ ☐	The question or problem that the lab was designed to answer is listed. The hypothesis is stated in the "If-and-then" format. It predicts the influence of the independent variable on the dependent variable. ☐ ☐	The procedures for controlling and measuring the dependent variable are defined and clear. A detailed, logical step-by-step set of procedures that were used for conducting the lab is listed. Safety concerns are missing form the procedures. ☐ ☐	Data tables and graphs neatly completed and totally accurate. Patterns or trends in data are noted. Data analysis is thorough. ☐ ☐	A response to both the question and hypothesis is provided. Some limitations and extrapolations of the data are cited. ☐ ☐	Language is used correctly and purposefully. Some words are misspelled, but with little or no effect upon the final product. The report is neat, legible, and presentable. ☐ ☐

Lab Report (continued)

	Title/ Introduction	**Background Research**	**Question/ Problem/ Hypothesis**	**Procedures**	**Data & Results**	**Conclusions**	**Language Usage**
Emergent 2	The title is stated in a rambling, non-concise fashion. There is an attempt within the title to state both the independent dependent variables and the results of the experiment. The title of the report is written in a declarative statement. The lead-in information lacks conciseness and clarity. ❑ ❑	Literature and prior observations are cited, but provide little insight into the phenomena to be included in the report. ❑ ❑	The question or problem that the lab was designed to answer is ill defined. The hypothesis is stated, but not in the "If-and-then" format. ❑ ❑	Some of the steps are understandable; most are confusing and lack detail. ❑ ❑	Data tables and graphs are completed, but lack accuracy. Patterns or trends within the data are difficult to discern. Data analysis lacks thoroughness. ❑ ❑	Presents an illogical explanation for findings. ❑ ❑	For the most part, language is used correctly. However, many words are misspelled, impacting upon the final product. The report borders on being sloppy, illegible, and not presentable. ❑ ❑
Novice 1	The title is stated in a rambling, non-concise fashion. There is no attempt within the title to state the independent and dependent variables and the results of the experiment. The title of the report is written in a declarative statement. The lead-in information provides little or no information that leads into the report. ❑ ❑	Literature and prior observations are not cited. ❑ ❑	The question or problem that the lab was designed to answer is not defined. There is no hypothesis. ❑ ❑	Not sequential, most steps are missing or are confusing. ❑ ❑	Data tables and/or graphs are missing information and are inaccurate. Consequently, patterns or trends within the data are not discernable. Little attempt is made at data analysis. ❑ ❑	Presents an illogical explanation for findings and does not address the question that guided the lab. ❑ ❑	Language is used incorrectly and without purpose. Many words are misspelled, impacting significantly upon the final product. The report is definitely sloppy, illegible, and not presentable. ❑ ❑

Writing to Inform in Science (Extended Constructed Response)

Name _____ Date _____ Course/Class _____

Task/Assignment _____

	Development	Organization	Audience	Language
Weights →				
Expert 4	Development: The writer provides accurate, specific, and purposeful scientific facts and concepts that are extended and expanded to fully explain the topic.	Organization: The writer establishes an organizational plan and consistently maintains it.	Audience: The writer provides scientific information relevant to the needs of the audience.	Language: The writer consistently provides scientific vocabulary and language choices to enhance the text.
Proficient 3	Development: The writer provides scientific facts and concepts that adequately explain the topic with some extension of ideas. The information is usually accurate and purposeful.	Organization: The writer establishes and maintains an organizational plan, but the plan may have some minor flaws.	Audience: The writer provides information most of which is relevant to the needs of the audience.	Language: The writer frequently provides scientific vocabulary and uses language choices to enhance the text.
Emergent 2	Development: The writer provides scientific facts and concepts that inadequately explain the topic. The information is sometimes inaccurate, general, or extraneous.	Organization: The writer generally establishes and maintains an organizational plan.	Audience: The writer provides some information relevant to the needs of the audience.	Language: The writer sometimes provides scientific vocabulary and uses language choices to enhance the text.
Novice 1	Development: The writer provides insufficient scientific facts and concepts to explain the topic. The information provided may be vague or inaccurate.	Organization: The writer either did not establish an organizational plan or, if an organizational plan is established, it is only minimally maintained.	Audience: The writer did not provide information relevant to the needs of the audience.	Language: The writer seldom, if ever, provides scientific vocabulary and uses language choices to enhance the text.